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PR30 Link Budget Considerations from a Component Perspective

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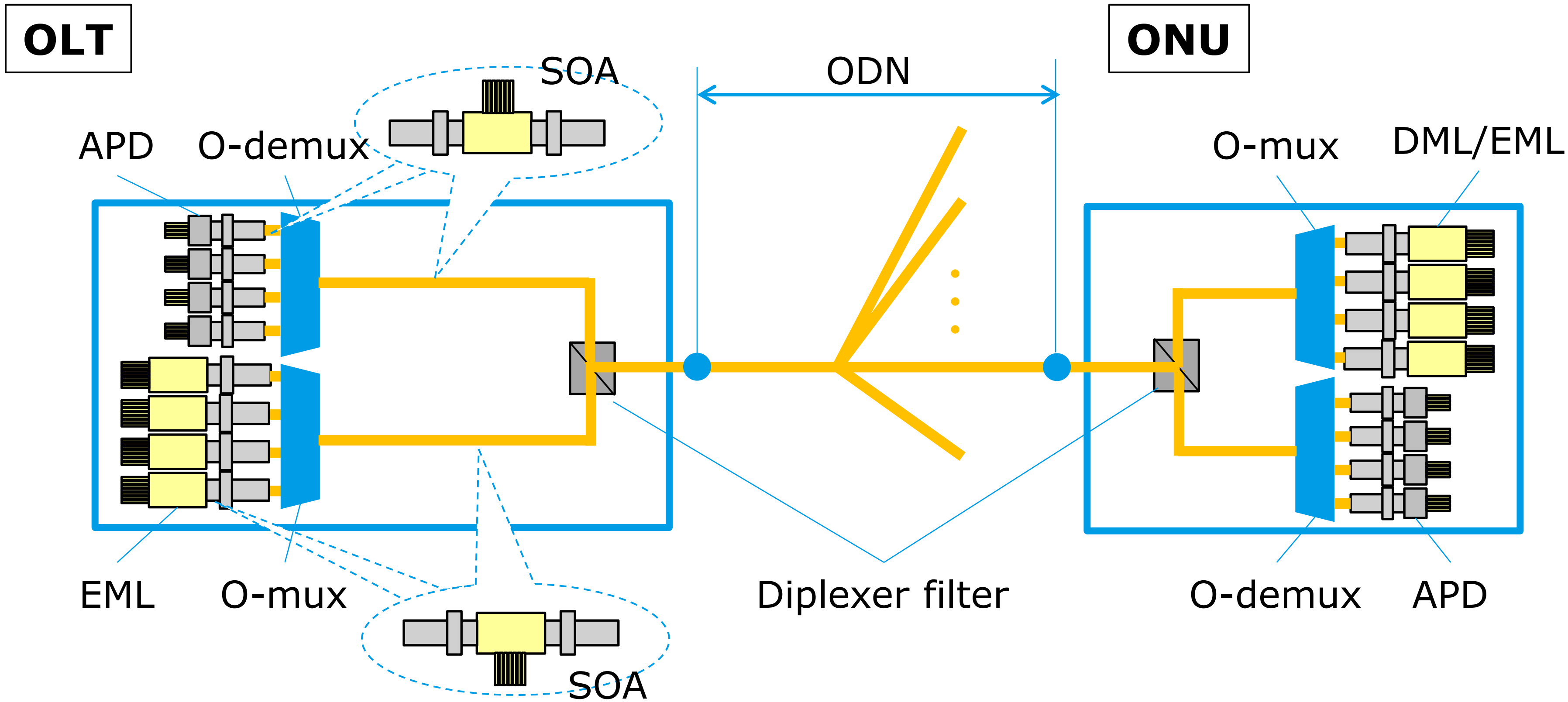
Outline / Introduction

- Previous presentations explored link budgets given various component capabilities
- 100G, PR30 most challenging
- This presentation looks at a common specification (25G/50G/100G) and indicates where further component assessment is needed to confirm specification values.
  - Emphasis on low-cost ONU

Schematics diagram of 100G-EPON network architecture



Total loss: 34.5dB [EML] or 35.0dB [DML] loss (tentative)

	O-mux	O-demux	Diplexer	ODN	TDP
Loss Penalty [dB]	1.5 (tentative)	1.5 (tentative)	0.5 (tentative)	29(PR30)	1.5(EML),2.0(DML) (tentative)

Vendor input survey result of laser

25G transmitter launch power and ER: responses

AVPmin (dBm)	number	mean	σ
EML	6	4.5	0.8
cooled DML	8	7.0	1.2
uncooled DML	6	4.7	1.5
ER (dB)			
EML	6	7.5	0.8
cooled DML	8	5.3	0.9
uncooled DML	6	4.7	1.0

When a range was given (maximum 1 dB), the higher value was chosen.

→**Inputs to be used in harstead_3ca_2_0716**

8

NOKIA

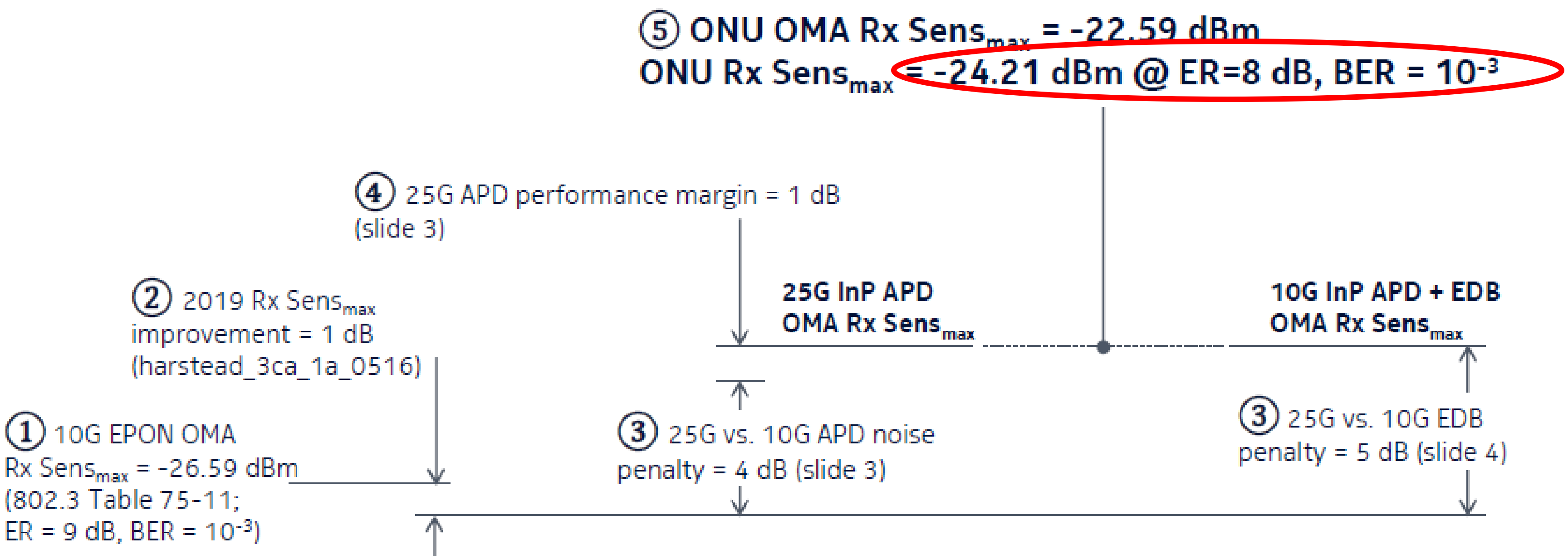
Ref. harstead_3ca_1a_0716

Vendor input survey results are good reference to consider 100G-EPON link budget.

25G APD sensitivity estimation (ONU)

Derivation of 25G PR30 receiver sensitivity specification, ONU

- Assume: OLT EML, with ER=8 dB per harstead_3ca_1a_0516
- Assume no FEC improvement over 10G EPON
- Assume no additional diplexer loss compared to 10G EPON (wavelength plan dependent)



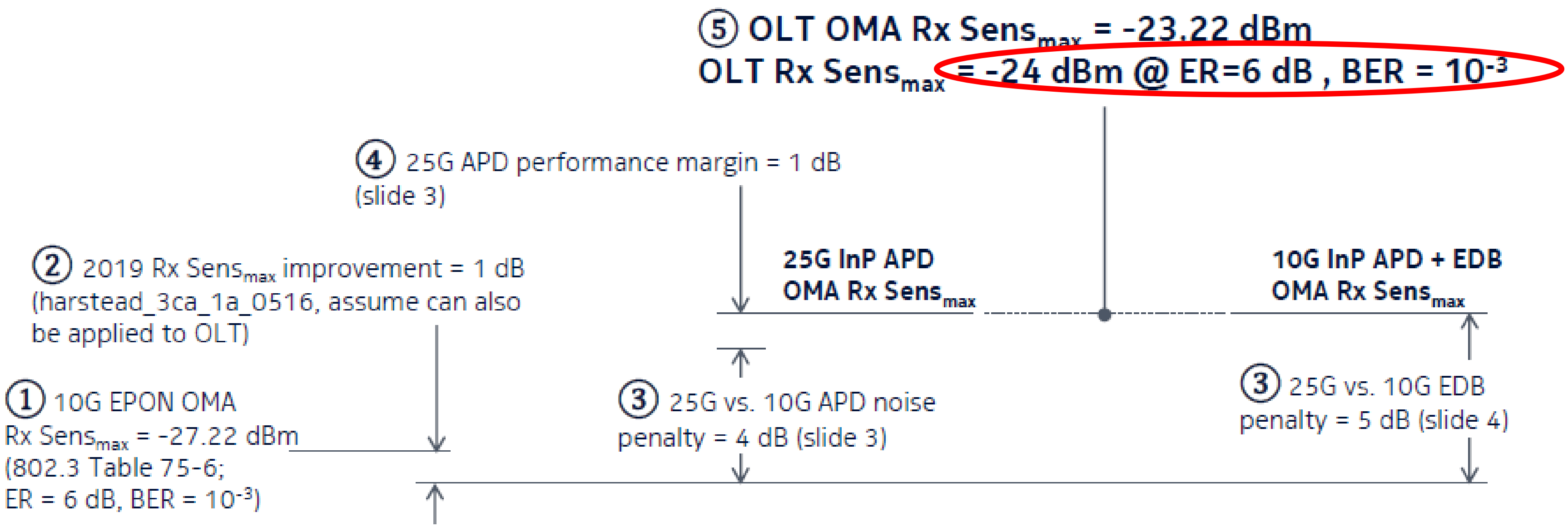
6 Public NOKIA

Ref. harstead_3ca_4_0117

25G APD sensitivity estimation (OLT)

Derivation of 25G PR30 receiver sensitivity specification, OLT

- Assume: ONU DML, with ER=6 dB per harstead_3ca_1a_0516.
- Assume no FEC improvement over 10G EPON
- With adjustment to the OMA method, a spec could be written that would also allow for an EML with lower power and higher ER (risk mitigation).



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Ref. harstead_3ca_4_0117

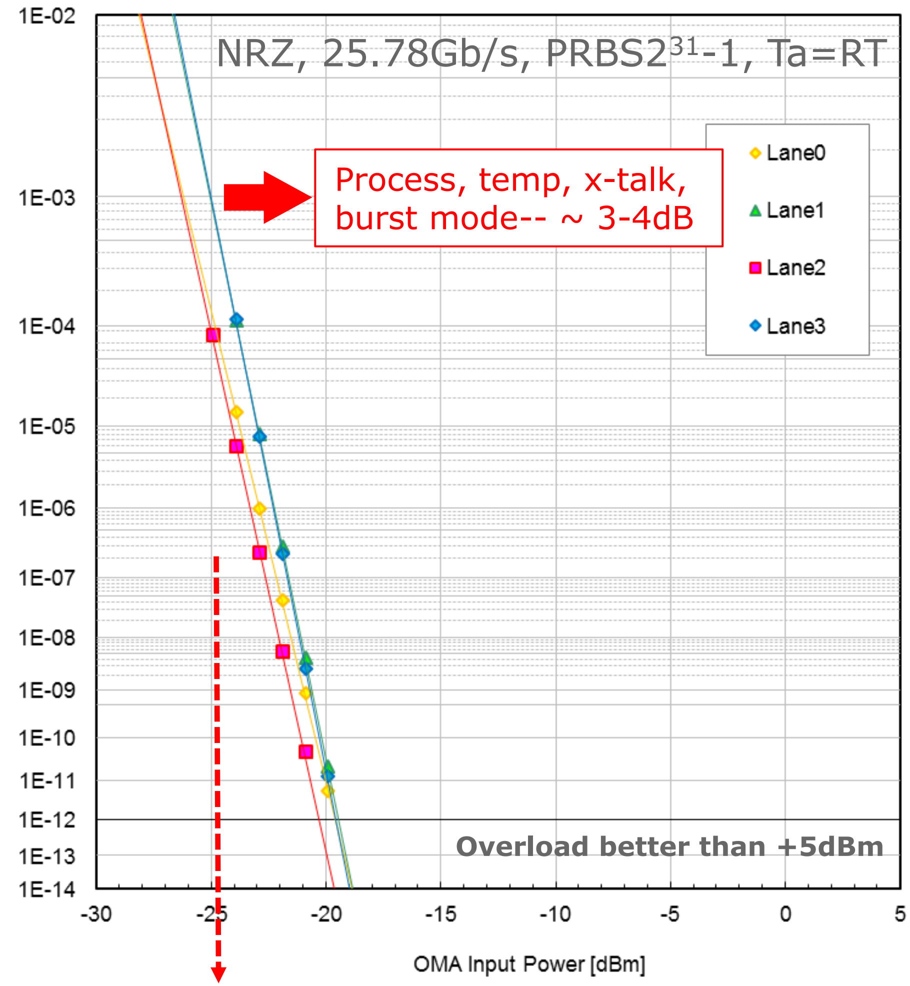
O-Demux Integrated 25G x 4ch APD ROSA

FEATURES

- LAN-WDM 4λ optical DMUX
- Four channel/limiting ROSA
- InP/InGaAs 25G APD
- SiGe Quad TIA
- Common integrated ROSA packaging

Common design

Prototype evaluation result



Equivalent ➔ -25.8dBm, avg (ER=6dB)
0.75dB (O-Demux) ➔ -26.55 dBm, avg

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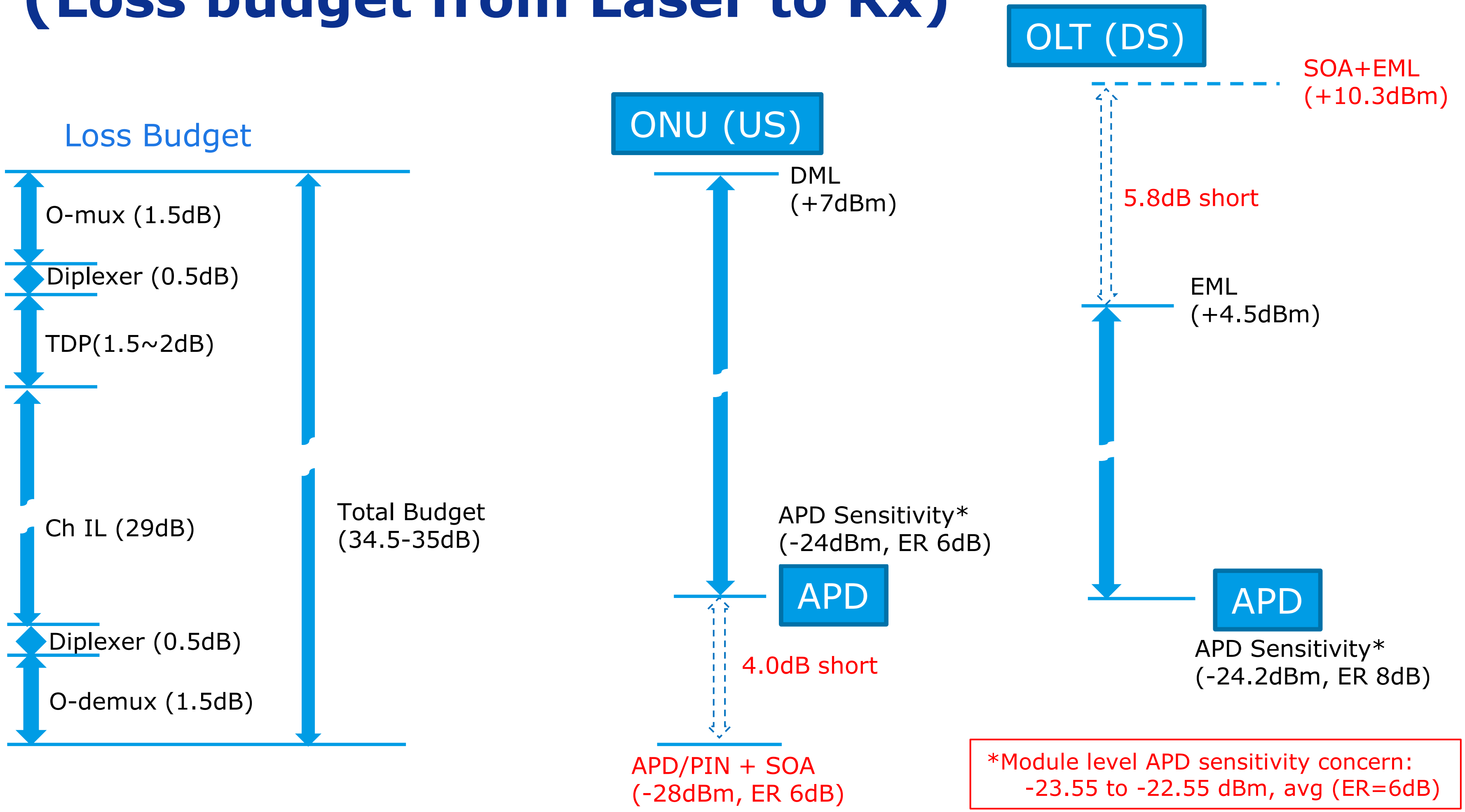
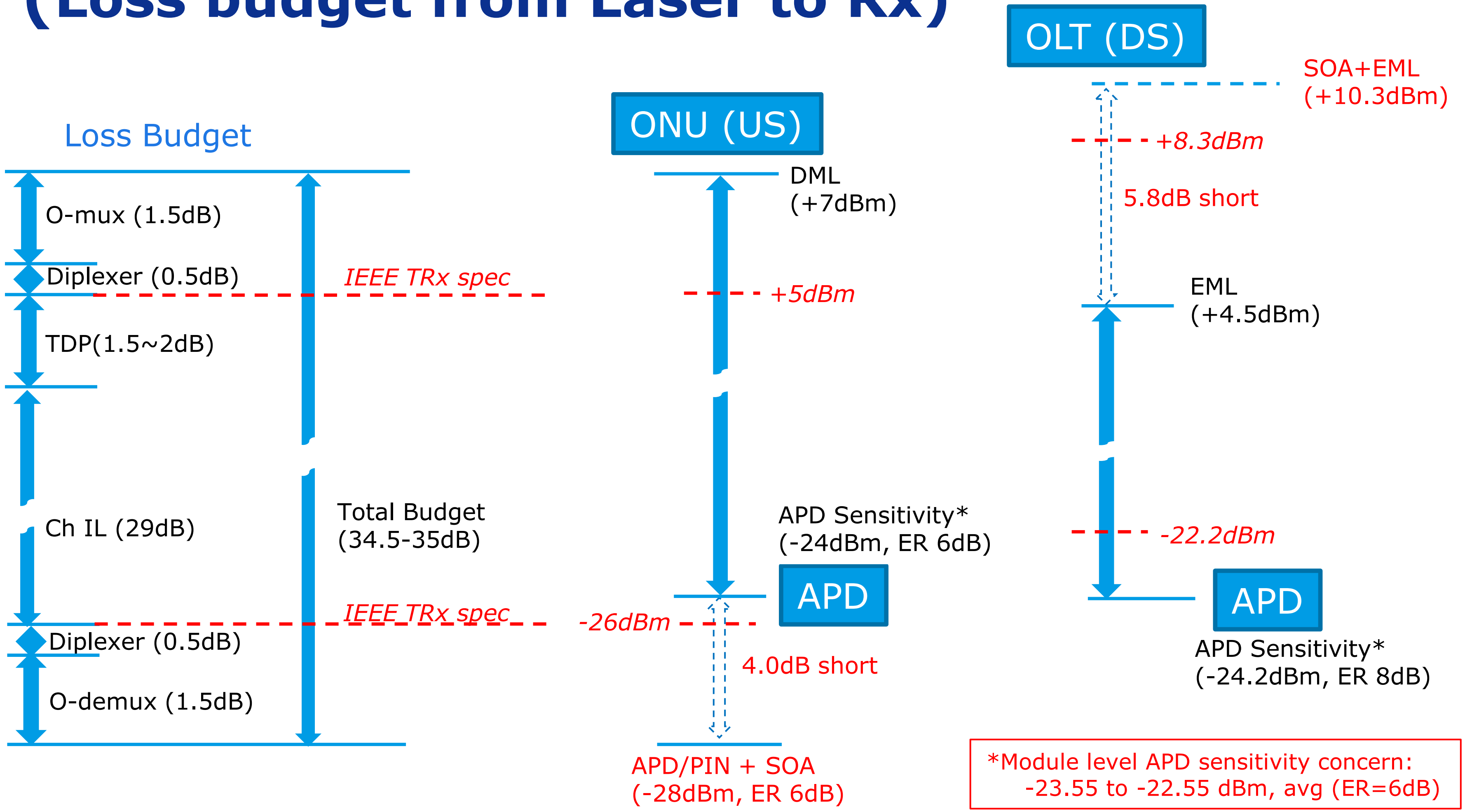
100G EPON (PR30)
(Loss budget from Laser to Rx)



*Module level APD sensitivity concern:
-23.55 to -22.55 dBm, avg (ER=6dB)

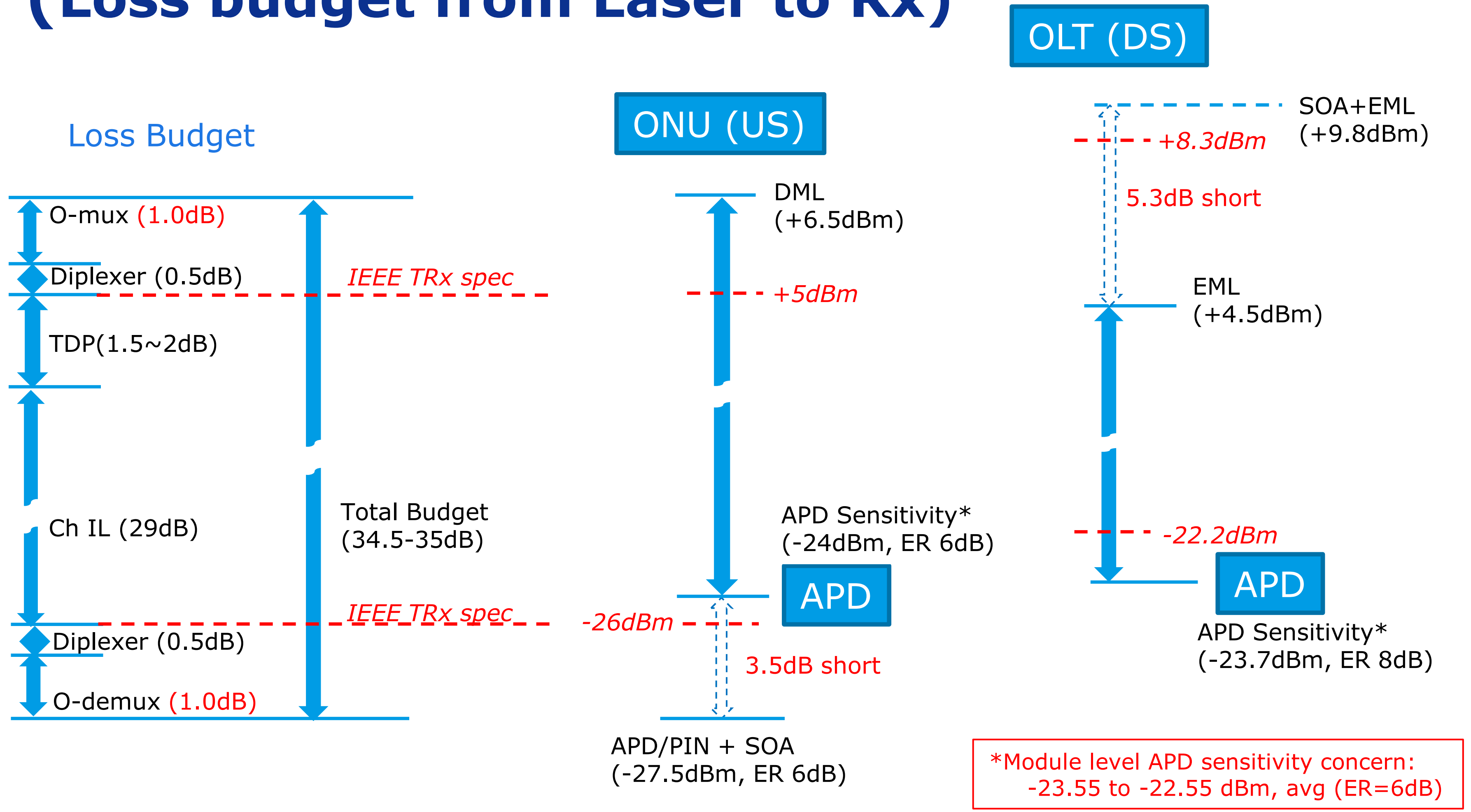
Need optical amplifier to realize 100G-EPON system

100G EPON (PR30)
(Loss budget from Laser to Rx)



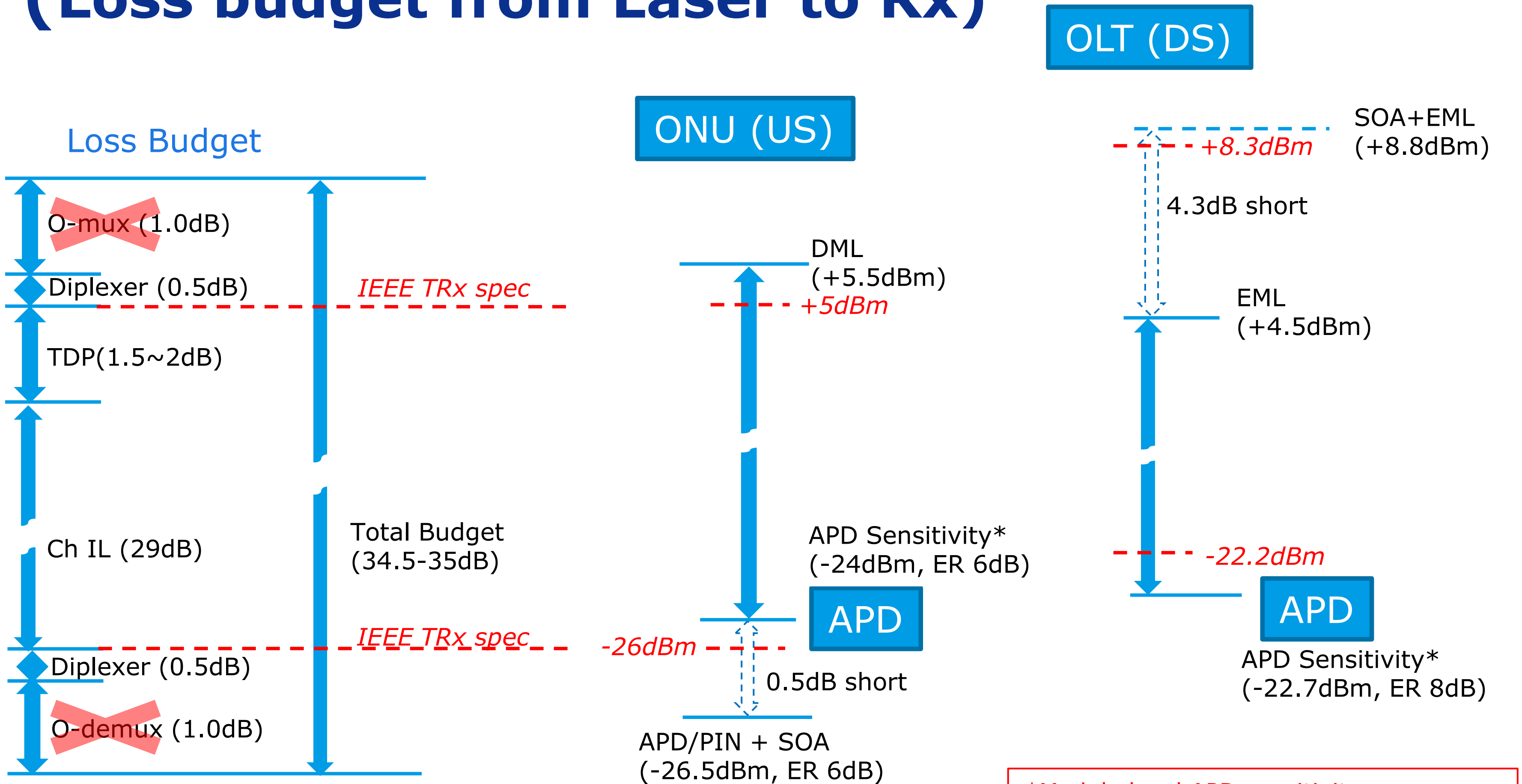
Need optical amplifier to realize 100G-EPON system

50G EPON (PR30)
(Loss budget from Laser to Rx)



Need optical amplifier to realize 100G-EPON system

25G EPON (PR30)
(Loss budget from Laser to Rx)



*Module level APD sensitivity concern:
-23.55 to -22.55 dBm, avg (ER=6dB)

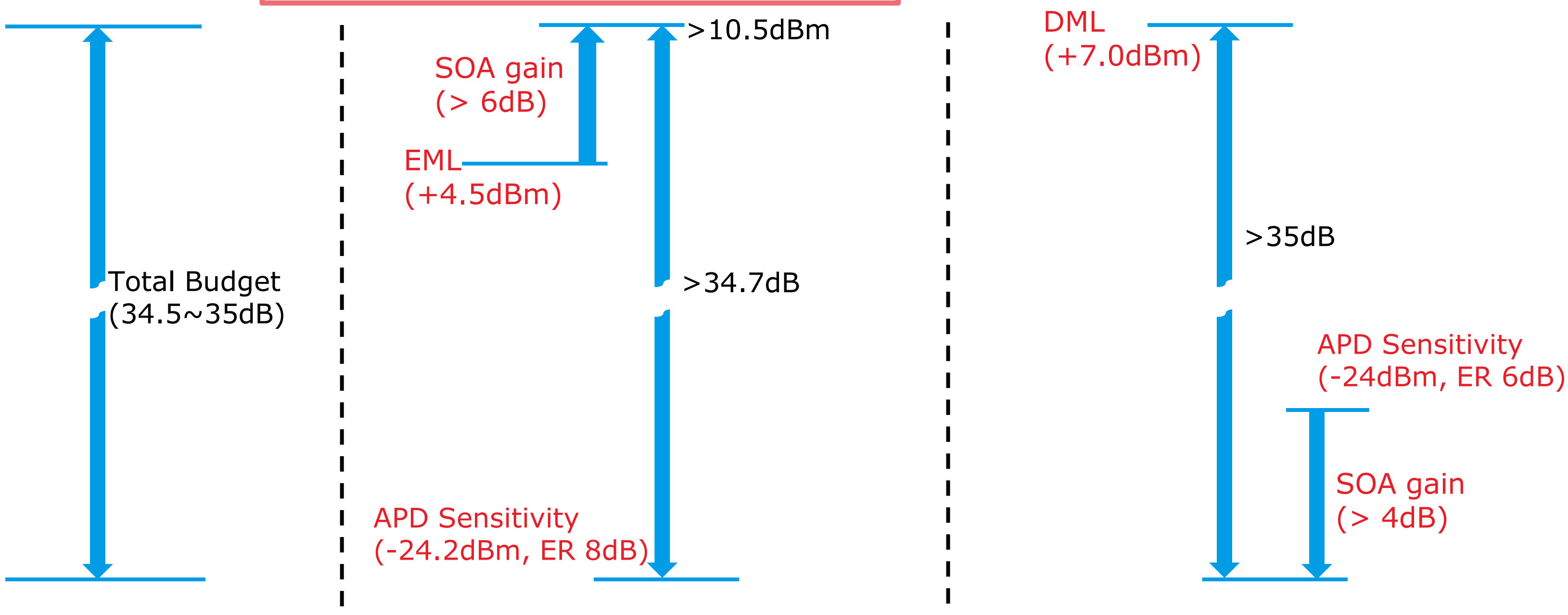
Need optical amplifier to realize 100G-EPON system

Device technology: Minimizing total cost and risk?

	Downstream	Upstream
OLT	Tx) EML+SOA (SOA integrated EML)	Rx) SOA+APD SOA+PIN-PD
ONU	Rx) APD	Tx) DML(cooled) / *EML*

Pre-Amp SOA options at OLT:
1. One discrete SOA for four wavelengths.
2. Four SOA integrated/APD.

Booster SOA options at OLT:
1. One discrete SOA for four wavelengths.
2. Four SOA integrated EMLs.



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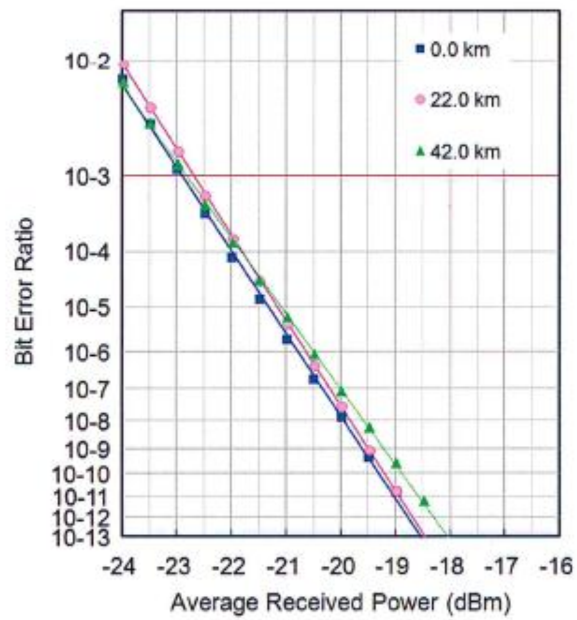
SEDI's SOA integrated EML for 10G-PON

Representative Characteristics

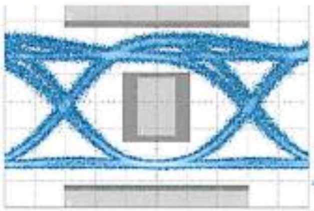
P_{fave}=10.8dBm, E_r=10.15dB

T_{LD}=40deg. C, 9.95Gbit/s, PRBS2^{31}-1

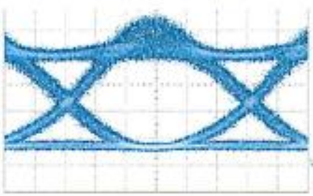
I_{LD}=110mA, I_{SOA}=256mA, Vo=-0.1V, V_{pp}=1.5V



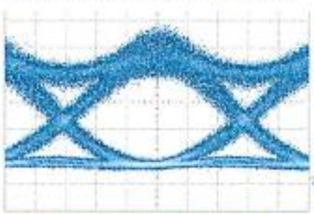
Back to Back



22km transmission



42km transmission



This technology could be applied to 25G EML

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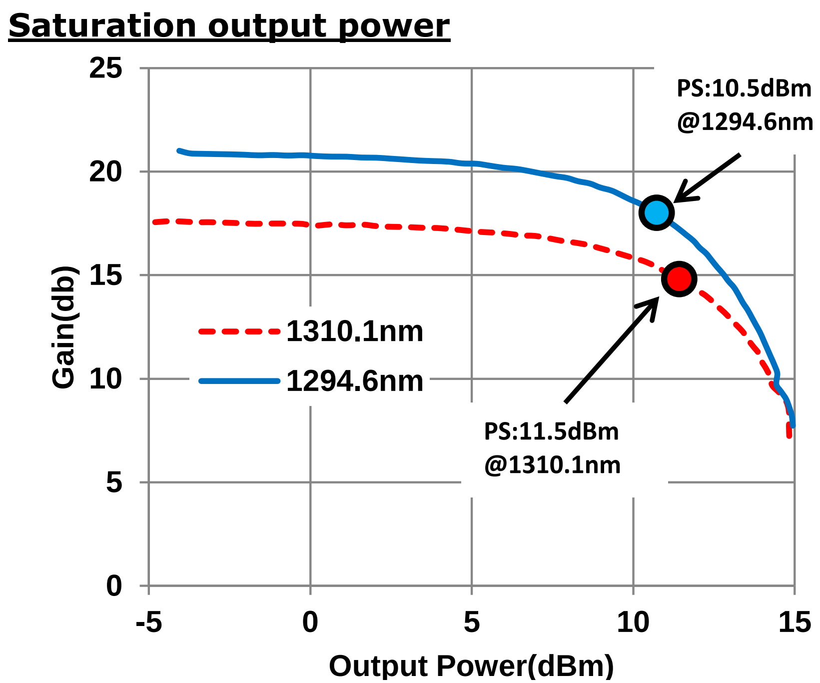
Example of SOA saturation power performance

- **Gain Characteristics**



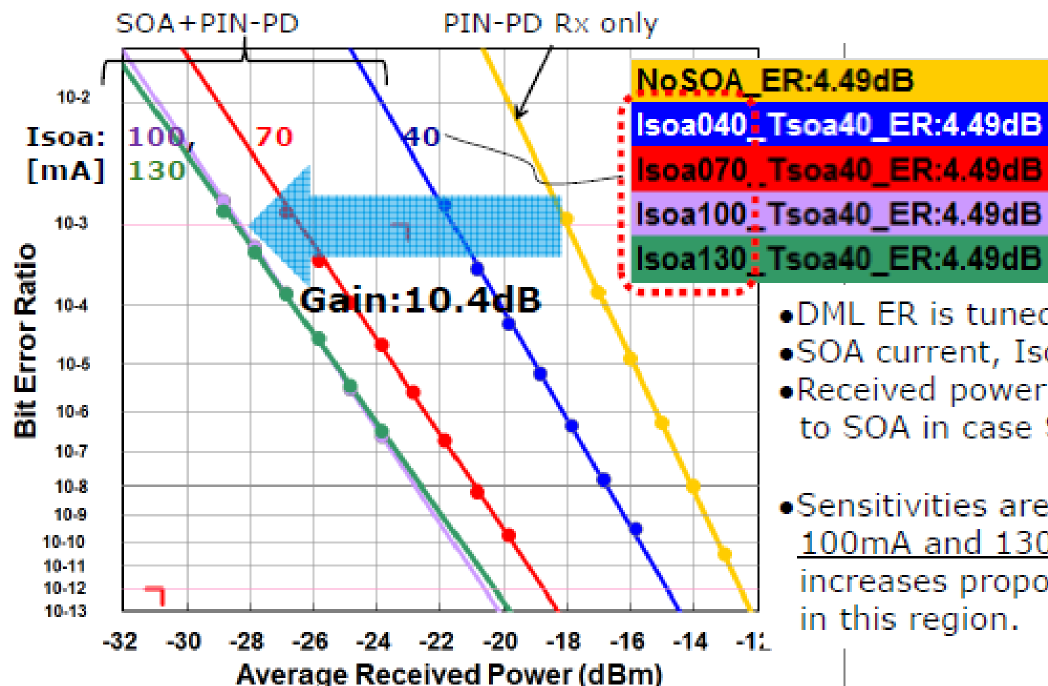
Tset:25deg.C Isoa:130mA

>10dBm saturation power doable, optimizing SOA parameter, higher saturation power could be obtained.

SOA+PIN sensitivity (alternative to APD, OLT)

Sensitivities of SOA + PIN-PD Rx

- PIN-PD ROSA and DML TOSA are the same samples used in tanaka_3ca_1116.
- SOA gain of sensitivity is 10.4dB@BER:1e-3 under Isoa:130mA and Tsoa:40degC with LAN-WDM filter of LR4/ER4.



- DML ER is tuned to 4.5dB in this result.
- SOA current, Isoa is biased 40 to 130mA
- Received power are defined as the input to SOA in case SOA pre-amp is applied.
- Sensitivities are almost same at Isoa 100mA and 130mA because ASE power increases proportionally to gain increase in this region.

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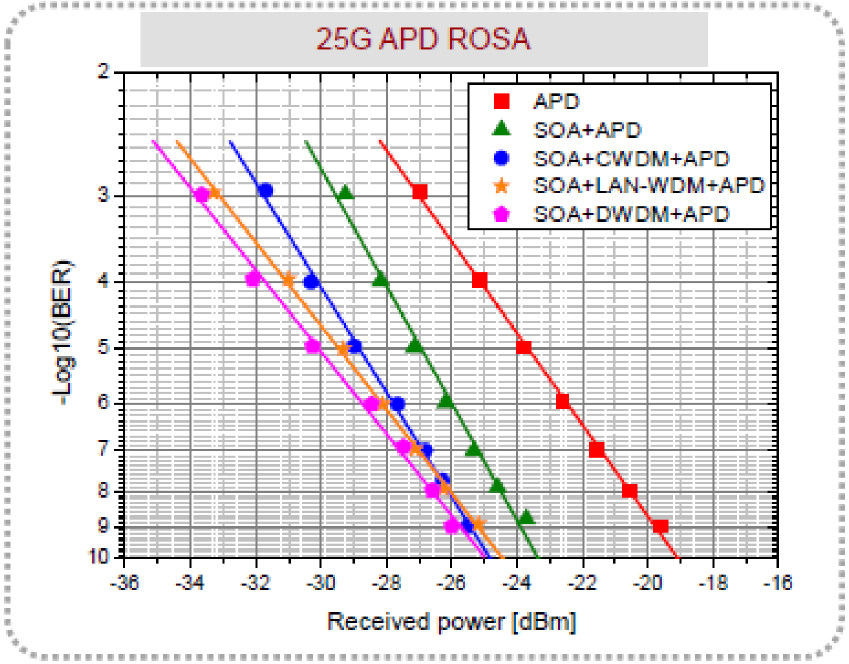
10-12 Jan. 2017

SOA+PIN could be solution.

Ref. tanaka_3ca_1a_0117

SOA + APD (ref: liu_3ca_1_0117)



- Compared with 25G APD, only using SOA as pre-amp., Rx. Sen. increased 2.2 dB.
- Using SOA and CWDM filter, Rx. Sen. increased 4.6 dB.
- Using SOA and LAN-WDM filter, Rx. Sen. increased 6.1 dB.
- Using SOA and DWDM filter, Rx. Sen. increased 6.6 dB.

Optical power @BER=1E-3		
	After SOA	After Filter
CWDM	1.8 dBm	-8.1 dBm
LAN-WDM	1.8 dBm	-5.9 dBm
DWDM	1.8 dBm	-18.9 dBm

	25G APD	w. SOA	w. SOA+CWDM filter (16.8 nm)	w. SOA+LAN-WDM filter (4.09 nm)	w. SOA+DWDM filter (0.9 nm)
Rx. Sen. (@BER=1E-3)	-27 dBm	-29.2 dBm	-31.6 dBm	-33.1 dBm	-33.6 dBm

SOA+APD could be solution.

Summary

1. Increase EML/DML output power
   - SOA integrated EML
     - SEDI has 10G SOA integrated EML, min. output power >+10.5dBm.
     - Possible non-linearity effect should be evaluated.
   - Add one or multiple discrete booster SOAs
     - Higher saturation output power characteristics is required .
       (especially in the case 4ch per 1 SOA. should be evaluated)
     - Possible non-linearity effect should be evaluated.

2. Improve APD sensitivity*
   - Add one or multiple optical preamp (SOA).
     - in the case of 4ch per 1 SOA, impact of each ch(λ) imbalance should be evaluated.
       (see next page)
   - OLT side needs to confirm burst mode operation.
     - APD + SOA: Dynamic range and ASE penalty.
     - PIN-PD + SOA: Dynamic range and sensitivity.

*25G APD sensitivity needs to be confirmed, because 25G APD is NOT mature in the field yet.
We should consider additional margin for the viable EPON specification.

- Thank You! -

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